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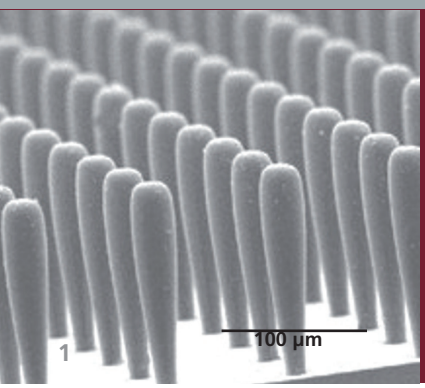

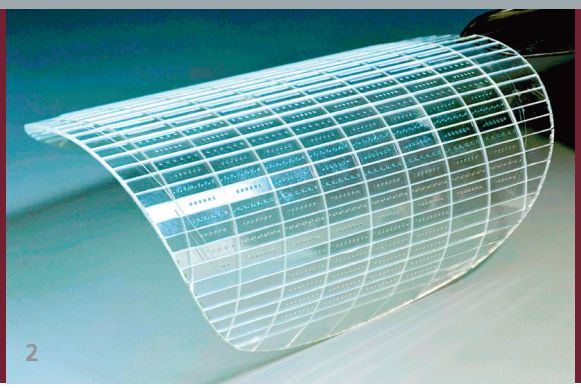

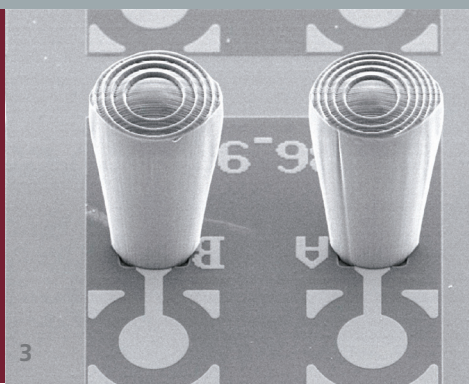

1 *Microoptics by combined technology VCSEL(GaAs) collimation (Fraunhofer IOF)*
2 *Sawed lense wafer: ORMOCER® based micro-lenses on glass (Fraunhofer IOF)*
3 *diffractive lenses on VSCEL wafer (CSEM, Switzerland)*

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ORMOCER®, NANOSCALED MATERIALS FOR MICRO-OPTICAL APPLICATIONS

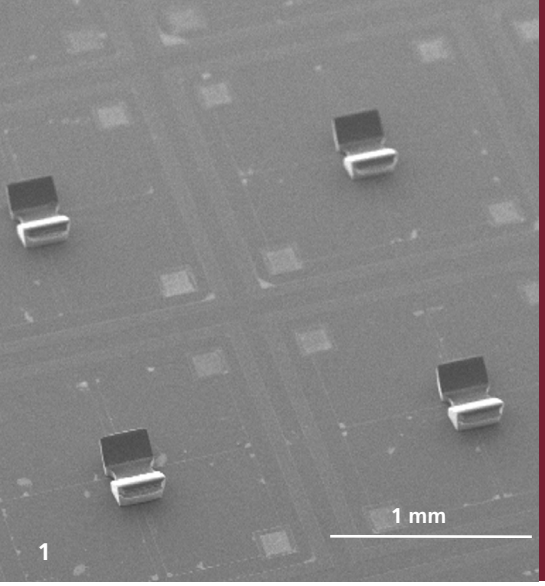
Motivation

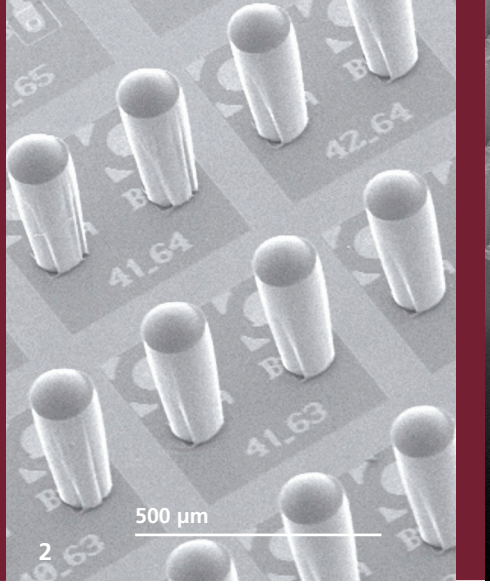
Within the last decade most applications in multimedia, info- and data-com as well as sensing have become highly integrated. Therefore, optical/photonic devices also have to be incorporated and adapted towards micro-processing with a focus on high integration levels, reliabiliy and low cost production. New optical materials with enhanced chemical, mechanical and thermal properties are being sought which are suitable for higher resolution requirements in new micro- and thin-film technology and which can withstand the harsh conditions of soldering, on-board, on-chip and wafer-scale processing.

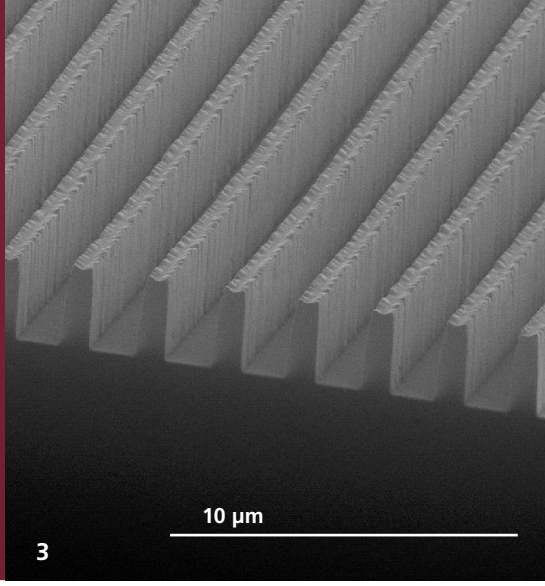
Solution

UV- and/or thermally curable hybrid inorganic-organic polymers, ORMOCER®s, with negative resist behavior have been developed and tested for microoptical applications.

They are composed of inorganic oxidic structures cross-linked or substituted by organic groups. The synthesis starts with organosilane precursors which react through sol-gelprocessing in combination with organic cross-linking of polymerizable organic functions. Due to these functionalities the properties of the ORMOCER®s are adjustable to the particular applications. Variation of composition and structure of the inorganic part (e. g. nano-buildingblocks) and the organic parts by chemical synthesis combined with adaptation to micro/nano system technology allows high flexibility in processing.







Main features of these materials are:

- Easily adaptable to thin film technology: spin-on of resins and lacquers with excellent planarization: the mainly ball-shaped nano-sized units (oligomers) smoothen the surface-topography, rms < 0.8 nm.
- New combined lithography and UV-embossing (soft lithography) based on ORMOCER®s enable wafer-scale production of micro-prisms or micro-lens arrays etc., nano-structures like diffractive and refractive optics as well as one-step processes for, e. g. microlenses including coupling-gratings on a nm-scale.
- Postbake at moderate temperatures (80 °C - 170 °C) allows processing on low-cost substrates such as FR4 sheets or PET foils and other polymers or sensitive integrated circuits.
- Despite low curing temperatures, the materials show thermal stabilities from 270 °C up to 400 °C (5 % weight loss in air, at 5 K/min).
- Very low loss in VIS and NIR area:
  < 0.1 dB/cm @ 633 nm
  < 0.2 dB/cm @ 1310 nm
  < 0.55 dB/cm @ 1550 nm
  with partial fluorination, the loss in NIR is reduced to < 0.3 dB/cm at 1550 nm.
- Refractive index is tunable by mixing ORMOCER®resins with indices between n = 1.48 and 1.60.
- Light stability in visible spectra better than in most standard optical polymers.
- The hybrid material can work as passivation and encapsulation in addition.

A number of basic hybrid polymers have been developed for a variety of applications and can easily be further tuned towards more advanced technology and target applications. Some are licensed and a first generation is available on the market for standard applications. The Fraunhofer ISC offers a materials and technology platform based on ORMOCER®s.

1 Replicated coupling prisms on detector chip wafers, prism height 100 µm, coupling efficiency 80% - can be soldered or flip-chip bonded (Fraunhofer IOF)
2 SEM image of processed microoptical components on VCSEL wafers
3 UV-embossed nano-grating in ORMOCER® (Fraunhofer IOF)